ACCESSIBLE INDOOR NAVIGATION SYMPOSIUM

2019 REPORT

APH

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SUMMARY

The 2019 Accessible Indoor Navigation Symposium, hosted by the American Printing House for the Blind (APH), brought together business and thought leaders from across the world to discuss the challenges of developing and implementing indoor navigation solutions. The panelists and symposium guests represented the public and private sectors, researchers and business leaders, developers and consumers. The event consisted of one day of panel discussions, which included topics such as future technologies, mapping, and standards, followed by one day of roundtable conversations and demonstrations of the indoor feature of APH's Nearby Explorer app and other company wayfinding applications.

The following report summarizes the concerns most frequently raised during the Symposium, as well as recommendations for how to approach each problem. The six identified issues are:

Interoperability

Cost

Infrastructure and Maintenance

Quality of Information

Security and Privacy

International Adoption

MODERATORS AND PANELISTS

BUILDING AN ACCESSIBLE CITY
Judy Dixon, Library of Congress (moderator)
Elizabeth Schaller, APH
Grace Simrall, Louisville Mayor's Office
Martin Swobodzinski, Portland State University

ACCESSIBILITY STANDARDS IN INDOOR WAYFINDING
Alexandra Blasgen, CTA (moderator)
Tiernan Kenny, Wayfindr
Axel LeBlois, G3ict
Hironobu Takagi, IBM Research – Tokyo

MAPPING THE WORLD FOR INDOOR NAVIGATION
Larry Skutchan, APH (moderator)
Vincent A. DiNoto, National Geospatial
    Technology Center of Excellence
Mike May, Envision
Michael Schnuerle, Louisville Mayor's Office
Antoine Riche, OpenStreetMap
Eric Sinagra, PathVu

FUTURE TECHNOLOGY IN INDOOR NAVIGATION
Kirk Adams, American Foundation for the
    Blind (moderator)
Chieko Asakawa, NavCog
Bob Kressin, KS Technologies
Anil Lewis, National Federation of the Blind
Mike May, Envision

SUSTAINABLE BUSINESS MODELS IN INDOOR NAVIGATION
Anil Lewis, National Federation of the
    Blind (moderator)
Austin Marron, Aira
Idan Mier, RightHear
Robert Panetta, HumanWare
Ilkka Pirttima, Blindsquare

APH President Dr. Craig Meador welcomes guests to the 2019 Accessible Indoor Navigation Symposium in Louisville, KY.

IDENTIFIED PROBLEM:
INTEROPERABILITY

Current Status of Interoperability:

Interoperability is a major consideration for developers and consumers alike. Consumers want fewer apps, and they want the ones they have to work well together. Wayfindr is working to address this by establishing standards for user interfaces that are not reliant on a particular navigation solution. While this does not immediately narrow down the number of apps needed for travel, it has begun to address some of the use concerns involved with having to master a variety of interfaces.

Meanwhile, developers are concerned with how the mapping and technology involved with indoor and outdoor navigation can work together for a seamless travel experience. One of the largest pilot areas for testing this is being developed by CNIB, which has mapped every business and organization within 1 kilometer/0.62 miles of their building. CNIB partnered with BlindSquare, a GPS app that supports indoor and outdoor travel, relying on beacon technology for indoor positioning. BlindSquare, in turn, has collaborated with RightHear, an app that provides indoor orientation information. The communication between the two apps allows users to easily switch back and forth.

Recommendations for Interoperability:

Interoperability hinges on collaboration. Partnerships with local governments, such as the partnership between APH and Louisville Metro Government, can lead to more robust, standardized mapping data. Civic partnerships can also reinforce the work done in cooperation with public transportation agencies, which will create a more seamless navigation experience. Public safety interests should also be a factor; mapping efforts that support navigation for people with visual impairments can also support data systems for first responders.

Standards will allow for mapping data with broad applications. It is impossible to know what technologies will be coming in the future, but the need for standardized, technology-agnostic mapping data already exists and will continue to be a key element of any seamless navigation solution. Applied standards will ensure interoperability between new and existing technology.

The user need for access to features in multiple apps should drive more collaborations like the one between BlindSquare and RightHear. A seamless transition between navigating indoors and out should be mirrored by a seamless transition between navigation apps. Further integration of navigation apps with other sources of information, such as review platforms and transit systems, should also be considered. Collaboration among accessibility companies is key. Another example is the Sendero Group partnership with Radius Networks, Boni Loud Steps, Indoo.rs, and Blindsquare in creating the Ningo database of beacons. APH also worked with the Ningo group by sharing beacons at Envision. This type of collaboration is key to future success.

IDENTIFIED PROBLEM:
COST

Current Status of Cost:

The general consensus, both from producers and consumers, is that the cost associated with indoor navigation solutions is too high. The price of beacons, especially when maintenance is factored in, is a barrier to more widespread adoption. The cost of maintaining this infrastructure has to be a primary consideration because the reliability of information presents a major safety concern.

One panelist pointed out that a major problem for their organization is figuring out how to add value to the service they provide without passing along the added costs to the consumer. Austin Marron, Chief Product Officer of Aira, mentioned that they do sell their service to businesses in the form of a geofence, which involves mapping but does not require beacons. The business pays per minute that a customer uses the service while in their store. Some navigation apps are free to consumers, but they require the individual to utilize a mobile device. Most navigation solutions only serve customers who can afford to purchase the latest technology.

Enticing businesses to invest in indoor navigation is also a challenge. Making the economic argument for that investment is difficult when the user population is so small; this is why mainstream use and buy-in is essential. Aside from an effective business case, which almost certainly must include users outside of the visually impaired community, good publicity is also a strong motivator for more widespread investment in and adoption of navigation technologies.

Recommendations for Cost:

One panelist pointed out that "indoor navigation will really succeed when it becomes super useful for sighted people." Tourism can be employed as an effective business case in some locations. Access to information in unfamiliar spaces, and especially in other languages, would entice a wider user base, which would in turn encourage businesses to invest in the required infrastructure. Big retailers are already utilizing beacons and other technology to provide product location information to sighted customers – this would be a potentially cost-efficient opportunity to collaborate using existing infrastructure and technology. Another recommendation for ensuring mainstream buy-in is to adopt universal design principles in user interfaces. The visual components of a navigation app interface need to be standardized and intuitive.

Competition and/or collaboration among the organizations working on indoor navigation will continue to play a role in developing cost-effective solutions. Consumers want to have multi-use apps, apps that can combine various navigation functions, such as points of interest and turn-by-turn directions. Collaborating to develop a multi-functional solution would almost certainly entice the largest possible consumer base. Additionally, combining resources can prevent duplication of effort which can in turn help to keep research and development costs down.

Commercial competition can also be leveraged to increase sales of indoor navigation solutions. By vocally supporting accessible businesses, advocacy groups can put pressure on those who have yet to invest in indoor navigation. Expanding expectations for accessibility to include indoor navigation, and then publicly lauding those organizations that invest in navigation solutions, will expand awareness and hopefully lead to more widespread adoption.

IDENTIFIED PROBLEM:
INFRASTRUCTURE AND
MAINTENANCE

Current Status of Infrastructure and Maintenance:

While many technologies are being investigated and employed as indoor navigation solutions, beacons are most widely used at this time. Beacons have a high up-front cost and become rapidly more expensive for businesses with larger physical footprints or a desire to increase the reliability of information due to the density needed to decrease variability. Many beacons run on batteries that require changing. This means someone must be paid to maintain them or an employee would be expected to spend a certain amount of time maintaining the replacement of the batteries. The panelists asked what incentive there is for the business community to maintain the beacons. This leads to the question of scaling up. With the level of labor required for mapping, installing, and maintaining beacons, does scaling up (if possible) of beacon use for indoor navigation make sense?

Another difficulty regarding beacons is the sharing of the equipment among information providers. Businesses are likely to install only one set of beacons, which means other companies do not have

> **" You have to think about the cost of maintaining a reliable infrastructure, because this is a mission critical application. You are talking about people's safety—people's ability to have a good experience, but also not to be hurt. "**
>
> **Mike May, Envision**

access to those locations. Users have to download numerous navigation apps for all the different places they visited. How do you incentivize the sharing of data/equipment among the blind community?

Yet another drawback of beacons is maintaining data on the physical layout of buildings. Often, floorplans are outdated and unreliable. Maintenance of current floorplans and updating of beacons and maps is dependent on the building/business managers.

Recommendations for Infrastructure and Maintenance:

As with most large-scale solutions, maintenance and infrastructure comes down to cost—cost to businesses/ agencies/governments/etc. to maintain equipment and cost to companies to provide and maintain their data. Therefore, taking advantage of existing infrastructure is crucial to indoor navigation success. Beacons, for example, can be used for several applications. The cost of adding wayfinding to an existing infrastructure of beacons might be outweighed by the return on investment for the additional

> **" Indoor navigation will really succeed when it becomes super useful for sighted people, because then you have economies of scale, you have economic justification, and you have justification for infrastructure steps to be taken. "**
>
> **Anil Lewis, NFB**

information that could be provided to consumers and businesses alike. As the private sector, specifically retail, has embraced this technology, it can be leveraged and used as a platform for new business cases without additional investment.

Regarding beacon maintenance, not all beacons are battery operated. Some larger companies, such as McDonalds, are using hard-wired beacons, which Radius Networks exclusively recommends. A cost analysis should be performed to see what makes the most sense.

Large corporations in areas of retail, hospitality, and transportation have the technology and scale to drive the creation of mainstream applications that could be used the world over. Sharing the infrastructure, standards, and maps (both indoor and outdoor) would decrease localization issues and increase use cases.

Retailers (and other businesses) want a seamless experience for customers, but often do not want to share data, including the maps of their locations. Finding a balance between wayfinding and privacy in order to provide users with a seamless experience is critical to advancing indoor navigation on a large scale. There are levels of physical building infrastructure and consumer data that businesses/agencies/governments do not want shared with the public. The distinction of that data needs to be identified and addressed to allay concerns, yet still provide some level of public information for wayfinding.

Wi-Fi Fingerprinting is the next exciting thing in indoor navigation. It appears to give better accuracy and there is no infrastructure to build up or install. This solution helps to address the issue of scaling by bringing down the cost of installation through the use of existing routers.

IDENTIFIED PROBLEM:
QUALITY OF INFORMATION

Current Status of Quality of Information:

Access to information is an ongoing struggle for the blindness community. Poorly designed websites, print-only options, and access to the internet itself are just a few issues that make it difficult for individuals with vision loss to obtain information. A growing concern regarding indoor (and outdoor) navigation is the amount and quality of information provided to users. How much is "too much information" when provided by an app? How many Points of Interest are too many? How do you standardize the information to make

> **66 We [NFB] don't pick a winner in the game. What we try to express to individuals is let the tool that you develop do both [provide information and instruction] and allow the user to customize how they like to engage with the information to use it to the best of their ability. 99**
>
> **Anil Lewis, NFB**

it useful for all apps; and, what type of information is more useful?

Regarding these issues, members of every panel were in agreement: quality of information provided was key, but amount and level of information received should be left to the user's preference. Determining what information is used, and how, is still important to know and understand, but offering layers of information that can be set individually within an app or website is the current preferred solution.

For example, some blind and visually impaired users prefer to know a route to a final destination, some prefer to know what is around them in a given space, and others want to know both sets of information, which for some might be considered too much noise. The quality of information is ultimately dependent on the user's perspective. In order to provide this level of flexibility, organizations must make available useful, up-to-date, granular data that aligns with current standards whenever possible.

The quality of information available to the user is the other primary concern. Michael Schnuerle with the Office of Civic Innovation in Louisville, Kentucky explained how the addition of information into OpenStreetMap such as building footprint data has created a rich tapestry of the city where before it was just lines of streets. Similarly, Eric Sinagra's company pathVu is advancing the quality of information about sidewalks in major cities by gathering and analyzing many kinds of data, which ultimately helps cities prioritize infrastructure improvements. Additionally, an app currently under development will take into account the quality of sidewalk routes and allow the user to adjust routes according to their specifications.

Quality of information can also be represented as levels of data. Antoine Riche, founder of Carto'Cité, explained it as starting with a road down the centerline as level zero. Level one is open data that identifies the sidewalks. The next level up from that is crowd-sourced data about the quality of the route. Another level up is the addition of the PathMeT tool, a device that measures sidewalks for accessibility characteristics, or Lidar surveying data, and so on.

Recommendations for Quality of Information:

While panelists agreed that quality of information was crucial to advancing indoor navigation, recommendations on how to obtain that information varied. Below is a list of recommendations from all five panel discussions.

- Ensure that a tool or strategy or technology has utility across the spectrum, that it's a mainstream utility. Sighted and blind persons should both benefit from an information and instructional tool for navigation.

- User-tailored interfaces—give customization options in any user interface.

- A standardized user interface with some basic guidelines is necessary for the sake of having a good experience.

- Deliver information at the point of need through the use of smart home technologies.

- Create partnerships between public and private sector together to explore needs, barriers, and solutions for better accessibility experiences for all.

- Increase the quality of information by creating levels of information. Start with what you know and continuously build up a database of information via different information sources.

> ❝ **It was a very real moment, and something that was very serious, perhaps people say we don't necessarily need to put that area of detail point of interest—"food court" and let that be enough. No, I think it was actually really important for us to hear that, in a way, the very specific venues that were available inside a larger space like the airport make a big difference, and really help to again engender that genuine authentic experience of independence that everyone is looking for.** ❞
>
> **Grace Simrall, Louisville Metro**

- Using Lidar technology, cities could publish useful and useable layers of information such as where the vegetation is in the city or where all the impervious surfaces are and so on.

- Develop assistive technology powered by Artificial Intelligence (AI) that supplements missing or weakened abilities.

- Consider the possibility of add-on information for specific apps such as restaurant menus or advertising, but keep the basic layer of information—who, what, where—available for everyone on a simple system.

IDENTIFIED PROBLEM:
SECURITY AND PRIVACY

Current Status of Security and Privacy:

Privacy and security are a concern for public and private sectors as well as individuals. People need to be able to access different levels of information for various reasons. On the other hand, public and private entities may have very specific needs for keeping some information, including a building's footprint, private and/or secure. How do you reconcile this issue for indoor navigation?

The data from the APH Accessible Communities Analysis online survey shows that in addition to Transportation, Work Place/Daily Living is the highest priority for accessibility improvements among people with visual impairments. However, information about private spaces and offices spaces is not usually available as open source data, which means it cannot be accessed for mapping without permission.

Mapping of indoor spaces impacts visually impaired and sighted people alike. There are many people who need to access building floor plans: architects/interior designers, building inspectors, government agencies, first responders, and so on. Having differing levels of access for public and private data is vital to supplying robust indoor navigation data for all users. Maintenance of maps and the security of the system have to be sustainable.

Additionally, while data has value, private sector businesses and consumers are protective of certain types of information. Businesses may have confidential/proprietary data or customer data that they don't want shared, while customers want to keep some level of privacy/control over personal data.

Lastly, the subjects of Points of Interest (POIs) being added by unknown/unverified sources and malicious tampering with beacon information were brought up during panel discussions. Currently, there is no regulation or verification of crowd-sourced information. Competency of data is a growing concern.

Recommendations for Security and Privacy:

It was widely agreed among all the panelists that regardless of the app used, all should have access to publicly available indoor data. Specific to security and privacy issues, standards should be created for particular features of widely accessed built environments (e.g., as transportation hubs). These environments often contain unique infrastructure such as security standards or passport machines, but with similar components such as gates or ticket counters.

For these environments and other public spaces, such as stores and government agencies, accessible versions of indoor/outdoor maps could be created as overlays to embedded maps on company/agency apps. POIs could then be added to the overlays. For example, if a government agency has a high level of security clearance, an overlay for a very basic indoor map of the building could be provided with accessible information for a person who has security clearance. Information is revealed (or hidden) as necessary.

This could also be profitable for someone who could create an embeddable solution for company apps, allowing them to hold on to their private/secure data while still offering accessibility for those that need it. The same tools used to create map routes and other information could be used here too.

Anil Lewis, Executive Director of Blindness Initiatives for NFB, suggested attending industry conferences and sitting on panels as ways to plant the seed about accessibility, make connections, and find out or share information about their customer experience. While industries may want to improve and make changes, it takes patience and persistence to get them to see things from an accessibility standpoint.

Verification of input sources and competency of data could be addressed in a couple of ways. One idea is to use a system where users could see exactly where the POI came from. Gregor Barnes, Senior Manager of Customer Operations for CNIB, suggested a solution similar to Waze where you leave notes or tips about how you navigated a space. The POIs could then be up voted or down voted based on usability. Or, again like Waze, a model could be created where a user could get "bonus points" for filling in the map. Another idea is to create a level of OpenStreetMap that, when selected, would only show user POIs from verified sources. Verified sources would come from trusted organizations such as CNIB, NFB, APH, and so on.

IDENTIFIED PROBLEM:
INTERNATIONAL ADOPTION

Current Status of International Adoption:

Right now, most of the work on indoor navigation is nation- or region-specific. This work is underpinned by the legal frameworks for equal rights for people with disabilities, which are, unfortunately, not yet universally adopted and have varying levels of specificity. In the United States, the Americans with Disabilities Act (ADA) serves as the foundation for efforts to prevent discrimination against people with disabilities. In many other parts of the world, the UN Convention on the Rights of Persons with Disabilities, and especially the ICT dispositions therein, addresses access to both physical environments as well as information and information systems.

Global adoption of methods and technologies is hindered not only by a lack of universal agreement on rights legislation, but also by a number of challenges identified throughout the panel discussions. Other barriers mentioned include international variation in floor numbering systems, language translation and support, and, most significantly, a lack of standards. In the United States, the Consumer Technology Association's Inclusive Audio-Based Network Navigation System Working Group is developing a national standard detailing requirements and recommendations for the design and implementation of indoor navigation systems for people with visual impairments. Internationally, Wayfindr's Open Standard has

been approved by the International Telecommunications Union (ITU-T F.291). This Open Standard "specifies how audio-based network navigation systems can be designed to ensure that they are inclusive and meet the needs of persons with visual impairments" and presents "a technology neutral approach by specifying the functional characteristics of the system."

Recommendations for International Adoption:

Strong international standards can lead to more rapid global adoption of navigation tools and techniques. Standards can also lead to government regulations that are more consistent, specific, and enforceable. Idan Meir, CEO of RightHear, mentioned that, in Israel, the country's regulations put the burden of adoption on businesses themselves, and that this type of regulation is starting to appear in other countries too. More collaboration among the organizations, and nations, represented at the symposium could help to expedite international adoption of indoor navigation standards and tools. Specifically, groups such as the Consumer Technology Association, International Telecommunications Union, and G3ict can promote awareness of policies and standards that can drive implementation.

IN CONCLUSION

There were 34 organizations represented from around the world at the first Accessible Indoor Navigation Symposium, making it a huge success. Several issues were addressed, and many future partnerships planned. There is, of course, much work to be done, and success depends on private and public sectors, government agencies, and accessibility companies working together for the greater good.

Based on the positive reception and comments from the symposium participants, APH intends to continue the momentum with a second Indoor Navigation Symposium planned for 2020. If you are interested in attending the next Indoor Navigation Symposium, please contact us at symposium@aph.org.

ABOUT AMERICAN PRINTING HOUSE

The American Printing House is a worldwide leader in designing innovative lifelong learning solutions for children and adults who are blind or visually impaired. In this fast-changing world, we believe in the power and necessity of learning to open the doors to educational success, satisfying employment, social inclusion, active citizenship, and personal well-being. We level the learning playing field by providing specialized technology, materials, products, and services that are essential for education and life.

To that end, APH is dedicated researching, developing, and implementing indoor navigation solutions.